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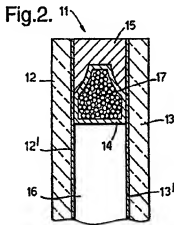
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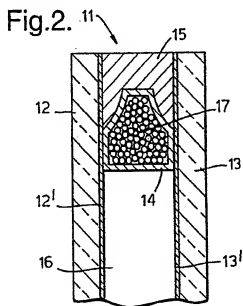
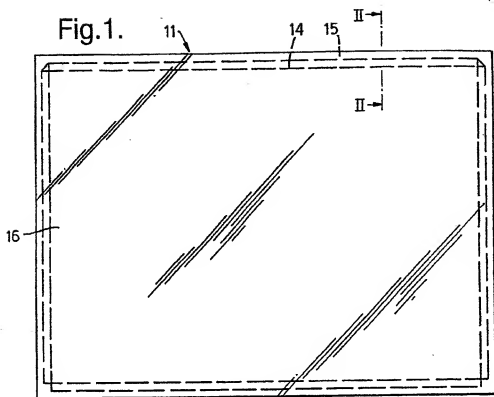
(54) Argon filled double glazing unit with low emissivity coatings

(57) A sealed double glazing unit 11 having two opposed glass panes 12, 13 spaced at least 12 mm apart, the space 16 between the panes being filled with argon, and each of the panes carrying on its face towards the other pane a low emissivity coating 12', 13', which could be a pyrolytic semiconductor metal oxide coating, such as fluorine doped tin oxide, tin doped indium oxide or aluminium doped zinc oxide, or could include a silver layer deposited by sputtering.



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DOUBLE GLAZING UNIT

The invention relates to double glazing units, and in particular to sealed double glazing units incorporating low emissivity coatings.

Glass bearing a low emissivity coating for use in thermally insulating glazing has been generally available for around 10 years (the term 'low emissivity coating' is used herein to refer to a coating which has an emissivity of about 0.2 or less calculated from measured infra red reflectance at near normal incidence in accordance with British Standard 6993). The early commercial coatings were composed of thin sputtered layers of copper or silver, sandwiched between reactively sputtered layers of metal oxide, the thickness of the metal oxide layers being selected to have an anti-reflection effect and optimise the light transmission of the coating. Such coatings have poor durability and are therefore generally used protected within a double glazing unit, on either surface 2 or, more usually surface 3, of the unit (with the surfaces being numbered, in conventional manner, 1 to 4 from the exterior, so that surface 1 is the exposed outer surface of the exterior pane, surface 2 the protected inward - of the unit - surface of that same exterior pane, surface 3 the protected inward - of the unit - surface of the interior pane, and surface 4 the exposed inner surface of the interior pane).

More recently, glass carrying a low emissivity coating of pyrolytically deposited semiconductor metal oxide, especially fluorine doped tin oxide coating, applied to the hot glass on-line during the glass production process, has become widely available. Such coatings are sufficiently hard and durable for use on the exposed outer and inner surface (surfaces 1 and 4), as well as on the inward facing surfaces (surfaces 2 and 3).

The use of a single low emissivity coating in a double glazing unit is, in general terms, sufficient to improve the performance of a double glazing unit to that expected of a triple glazing unit without any such coating. Thus the U value of the unit may be reduced, typically, from 2.8 to $1.9 \text{ W/m}^2\text{K}$ (for a unit comprising 2 panes of 4 mm clear float glass with an airspace of 12 mm between the panes).

Recently, there has been a demand for even higher insulating performance, and it has been proposed to apply a sputtered silver/metal oxide low emissivity coating to the uncoated surface of a glass pane carrying a more durable pyrolytically deposited semiconductor metal oxide low emissivity coating, and to incorporate that pane in a double glazing unit with the relatively soft metal coating on surface 3 (protected within the unit) and the more durable pyrolytic coating on the exposed inner surface 4.

Unfortunately, while the pyrolytic coating is sufficiently durable for use on an exposed coating, it is so hard that it is vulnerable to marking on contact with a softer foreign body, for

example a metal roller supporting the glass. Since architectural glass being sputter coated is conventionally supported on metal rollers there is clearly a risk of the pyrolytic coating becoming marked during the process used to apply the metal/metal oxide coating to the other surface. We have therefore explored the possibility of using two separate coated panes (e.g. two panes each bearing a single pyrolytic low emissivity coating) to produce an insulating glazing unit.

Calculations show that, when two panes of 4 mm clear float glass each bearing a low emissivity coating (emissivity equal to 0.16) are assembled to form a sealed double glazing unit of 16 mm airspace, the resulting unit will have a U value of approximately $1.52 \text{ W/m}^2\text{K}$ with the coatings on surface 2 and 3, or $1.41 \text{ W/m}^2\text{K}$ with the coatings on surface 2 and 4. Thus, there is a clear thermal performance advantage in using one of the coatings on the exposed face of the interior pane of the unit.

It is known that the thermal insulation performance of a sealed double glazing unit may be achieved by replacing the air in the sealed "airspace" between the panes with argon, which has a lower conductivity than air. Calculations show that, when argon is used to replace air in the unit referred to above, with the low emissivity coatings in the preferred (from the viewpoint of thermal performance) surface 2 and surface 4 arrangement, the U value is reduced from $1.41 \text{ W/m}^2\text{K}$ to $1.26 \text{ W/m}^2\text{K}$, an amount of $0.15 \text{ W/m}^2\text{K}$. While, from the calculations referred to above, this might

be expected to be the optimum and preferred arrangement, the present inventor took the precaution of checking the predicted performance for a similar argon filled unit but the low emissivity coatings in the surface 2 and surface 3 arrangement. In this case, the use of argon produced, surprisingly, a significantly greater improvement in the performance of the unit, reducing the U value from $1.52 \text{ W/m}^2\text{K}$ to $1.27 \text{ W/m}^2\text{K}$, i.e. by $0.25 \text{ W/m}^2\text{K}$ to a value substantially the same as that obtained with the coatings in the surface 2, surface 4 disposition. This is a significant result, since it shows that, in such a high performance argon filled unit, two low emissivity coatings may be used both facing inward towards the 'airspace' without significant detriment to the thermal performance, but with the advantage of not leaving the low emissivity coatings exposed. This is valuable, even when using the durable pyrolytic semiconductor metal oxide coatings since, as noted above, such coatings are so hard as to be vulnerable to marking on contact with a softer foreign body and it is preferable to avoid risk of such contact (for example, contact with a metal ring worn by a housewife cleaning the window) which might mark the coating.

According to the present invention, there is provided a sealed double glazing unit comprising two opposed spaced panes, with spacing means between the panes and a seal sealing a space between the panes, wherein each pane carries a low emissivity coating on its face toward the other pane, the panes are spaced

at least 12 mm apart and the space between the panes is filled with argon.

The dependence of the effect of argon filling on thermal performance is attributed to convection, which only becomes significant in units with an 'airspace' of about 12 mm or greater. As the 'airspace' increases, heat losses through thermal conduction across the 'airspace' decline, while losses through convection increase, and the invention will thus generally be used in units in which the panes are spaced between about 14 mm and about 24 mm apart.

The invention is illustrated, but not limited, by the following description with reference to the accompanying drawings in which:

Figure 1 is a schematic plan view of a double glazing unit in accordance with the invention.

Figure 2 is a section on the line II-II of Figure 1.

Referring to both Figures 1 and 2, a double glazing unit, generally designated 11, comprises two opposed spaced parallel panes of glazing material, 12 and 13, spaced apart by a hollow section rectangular spacer frame, generally designated 14, around the periphery of the unit adjacent the edges of the panes. The hollow in the spacer frame 14 may be filled with particulate dessicant 17. A seal 15 is provided around the periphery of the unit in the channel formed between the spacer frame and the panes, and an additional seal (not shown) is provided in known manner

between the panes and the adjacent parallel spacer walls. Each of the panes carries a low emissivity coating 12¹, 13¹ on its inward surface, and the panes, together with the spacer frame 14 and seal 15, define a sealed 'airspace' 16 filled with argon.

Each of the panes may be of glass or plastics glazing material, but they are preferably both of clear float glass. The thermal performance of the unit is not heavily dependent on the thickness of the panes, and the panes are commonly of 4 mm thickness, although other thicknesses, normally but not necessarily, thicknesses in the range 3 to 6 mm, may be used.

Either or both of the coatings may be a sputtered metal coating, as described above, but in one preferred embodiment, each pane carries a pyrolytic semiconductor metal oxide coating as the low emissivity coating, for example, fluorine doped tin oxide, tin doped indium oxide or an aluminium doped zinc oxide coating. The panes are at least 12 mm, and preferably about 16 mm, apart.

In a further preferred embodiment, the low emissivity coating on the outer pane is a coating comprising a layer of silver. Such coatings are generally deposited under low pressure, for example by sputtering, and the silver layer is typically sandwiched between metal oxide layers which may serve as anti-reflection layers increasing the light transmission of the coated glass. The silver layer typically has a thickness in the range 8 nm to 25 nm, but is preferably of a thickness, for example 11 nm to 16 nm, such that the unit has a visible light transmission of at least 55%.

preferably at least 60%, and a total heat transmission of less than 50%. (For the purpose of the present specification and claims, the expression "light transmission" is used to refer to the percentage of visible light, having a spectral distribution corresponding to CIE Illuminant D65, at normal incidence transmitted through the glazing, the expression "light reflection" is used to refer to the percentage of that visible light reflected by the glazing, and the expression "total heat transmission" is used to refer to the percentage of solar radiant heat (radiation having the spectral distribution defined by Moon's curve for air mass²) at normal incidence that is transferred through the glazing by all means). While thinner silver layers may be used, the increase in silver thickness required to achieve the solar control performance set out above is modest, results in only a moderate increase in the visible light reflection of the unit, and leads to an improved U value. On the other hand, a significantly greater increase in silver thickness, for example to a value such that the unit has a total heat transmission below 35%, results in a substantially greater visible light reflection (which, apart from reducing the visible light transmission, is in itself aesthetically undesirable), without any significant improvement in U-value.

An outer pane carrying a silver low emissivity coating on surface 2 may be used in combination with an inner pane carrying a silver low emissivity coating on surface 3, but is more

conveniently used in conjunction with an inner pane carrying a pyrolytic semiconductor metal oxide coating, for example fluorine doped tin oxide, tin doped indium oxide or an aluminium doped zinc oxide coating, on surface 3.

The performance figures for a number of units in accordance with the invention are set out in the accompanying Table.

In each case, the unit is as illustrated in the accompanying drawings (except that, when a silver based low emissivity coating is used, a strip of coating is removed from the glass where the spacer frame 14 and seal 15 abut that coating); one pane (intended for use as the inner pane) is a pane bearing a semiconductor metal oxide coating having an emissivity of 0.16 (for example, the coated glass available in commerce from Pilkington Glass Limited, St Helens, England, under the trade name Pilkington K Glass); and the unit has an 'airspace' of 16 mm i.e. the panes are spaced 16 mm apart. The constitution of the coating on the second pane (intended for use as the outer pane), which is a pane of 4 mm clear float glass carrying a low emissivity coating, is indicated in the first column of the accompanying Table which also sets out the light transmission, light reflection, total solar heat transmission and U value of each of the units when the unit is oriented with the second pane as the outer pane i.e. toward the source of incident radiation.

Table

Outer Pane	Light Transmission	Light Reflection	Total Solar Heat Transmission	U value W/m ² K
PILKINGTON K GLASS (semiconductor metal oxide coating)	71	18	-	1.27 (1.26)
KAPPAFLOAT NEUTRAL glass	73	13	60	1.21 (1.14)
SUNCOOL HP CLEAR glass	62	22	46	1.10 (1.00)
SUNCOOL HP SILVER glass	44	44	31	1.11 (1.01)

PILKINGTON, K GLASS, KAPPAFLOAT and SUNCOOL HP are all trade marks of Pilkington plc. KAPPAFLOAT NEUTRAL and SUNCOOL HP are used in respect of coated glasses bearing a low emissivity coating comprising a silver layer sandwiched between metal oxide layers. In the coating of KAPPAFLOAT NEUTRAL glass, the thickness of the silver layer is about 9 nm; in SUNCOOL HP CLEAR glass, the thickness of the silver layer is about 13 nm, in SUNCOOL HP SILVER glass, the thickness of the silver layer is about 20 nm.

The results show not only the extremely high insulation performance achieved with two low emissivity coatings in argon filled units, even with the coatings disposed on surfaces 2 and 3 of the unit, but also the variation in performance with the precise nature of the low E coating used on surface 2.

The U values of corresponding units, in which the pane used as the inner pane is oriented with the coating on its exposed surface 4, rather than being protected within the unit on surface 3, are given in brackets in the final column of the Table. For the unit in which both low emissivity coatings are of semiconductor metal oxide, the difference in U value resulting from the difference on orientation of the inner pane (0.01) is shown to be negligible. For the units in which the low emissivity coating on the outer pane is a silver based coating, the differences in U value resulting from the differences in orientation of the inner pane are somewhat greater (shown as 0.07, 0.10 and 0.10 respectively) but are still small, and, surprisingly, are substantially less than the corresponding differences in U values when the units are filled with air rather than argon (0.14, 0.17 and 0.18 respectively).

The Table shows a reduction in light transmission and total solar heat transmission and a corresponding increase in light reflection as the low emissivity coating on the outer pane is changed from a semiconductor metal oxide coating to a silver based coating, with the changes continuing as the thickness of the silver layer in the silver based coating is increased.

While the U value follows the same trend as light transmission and heat transmission with the change from a semiconductor metal oxide coating to a silver based coating, it is interesting to note that the U-value shows a minimum as the thickness of the silver layer changes (compare U-values for units having KAPPAPLOAT NEUTRAL glass, SUNCOOL HP CLEAR glass and SUNCOOL HP SILVER glass out panes). Since the increase in silver layer thickness in the above sequence is associated with a continuing increase in light reflection, which is commonly considered aesthetically undesirable, we prefer to use, for the outer pane, a pane with a low emissivity coating having a silver layer of intermediate thickness to provide a unit having a visible light transmission of at least 55% and a total solar heat transmission of less than 50%.

However, whichever of the suggested low emissivity coatings is used on the inner pane, it is notable that the use of the coatings disposed on surfaces 2 and 3 of the unit, in accordance with the invention, protects from marking in service, without any significant deleterious effect on the high performance of the unit.

Claims

1. A sealed double glazing unit comprising two opposed spaced panes, with spacing means between the panes and a seal sealing a space between the panes, wherein each pane carries a low emissivity coating on its face toward the other pane, the panes are spaced at least 12 mm apart and the space between the panes is filled with argon.
2. A sealed double glazing unit according to claim 1 wherein each of the said coatings is a semiconductor metal oxide coating.
3. A sealed double glazing unit according to claim 1 or claim 2 wherein each of the said coatings is a fluorine doped tin oxide coating.
4. A sealed double glazing unit according to claim 1 wherein the outer pane carried a low emissivity coating including a silver layer on its face towards the inner pane.
5. A sealed double glazing unit according to claim 4 wherein the thickness of said silver layer is such that the unit has a visible light transmission of at least 55% and a total solar heat transmission less than 50%.

6. A sealed double glazing unit according to claim 4 or claim 5 wherein the inner pane carries a low emissivity semiconductor metal oxide coating on its face towards the outer pane.
7. A sealed double glazing unit according to claim 6 wherein the low emissivity metal oxide coating is a fluorine doped tin oxide coating.
8. A sealed double glazing unit according to any of the preceding claims wherein each of the said panes is of glass of thickness about 4 mm.
9. A sealed double glazing unit according to any of the preceding claims wherein the panes are spaced between about 14 mm and about 24 mm apart.
10. An argon filled sealed double glazing unit substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.